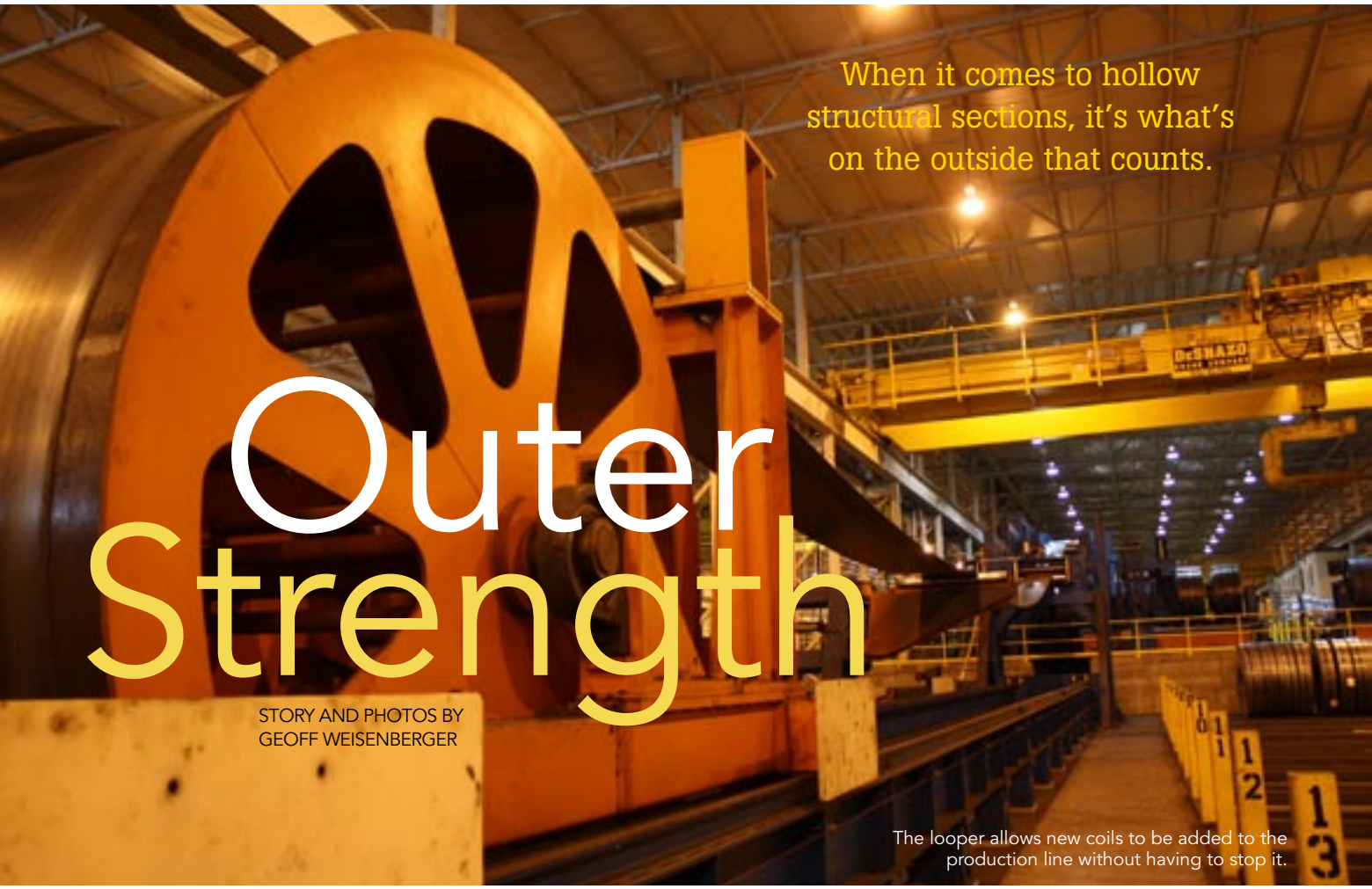


When it comes to hollow structural sections, it's what's on the outside that counts.

Outer Strength

STORY AND PHOTOS BY GEOFF WEISENBERGER

The looper allows new coils to be added to the production line without having to stop it.

THE FIRST IMAGE THAT POPS TO MIND when thinking about structural steel is usually a wide-flange member, with its familiar "I" end profile. But lately, circles, squares, and rectangles have been making their own case for steel symbolism; hollow structural sections (HSS) are a major part of the structural steel presence these days. Roughly 3 million tons of HSS were produced in North America in 2008, compared to approximately 5.6 million tons of W-shapes.

A visit to the country's newest HSS mill, in Decatur, Ala., provided some insight on how hollow structural shapes come to be. The plant, which opened in 2006, belongs to Independence Tube Corporation and is one of the company's three facilities; the others are in Chicago and Marseilles, Ill. This newest facility produces hollow rounds and shapes for structural fabricators and steel service centers; the other two facilities also produce structural sections, as well as steel tube for agricultural machinery. Independence is currently installing another mill in Marseilles, which will allow them to produce more rounds from 1.66 in. OD through 4 in. OD; it will be operational this fall.

As Independence's newest plant, Decatur is also the most automated. However, division manager John Helinski notes that machines can never completely replace people in the HSS industry. "I don't think you can ever take people out of the tube-making process," he says. "Automation can only take us so far. There is a lot of assumption on the part of newer employees is that the machine can do it all on its own. Machines can reset themselves back to an original position for size setup, but that's based on sensors. But what if the sensors are wrong? People need to calibrate them. Also, if the sensors fail completely, operators still need to know how to set up the equipment manually."

In terms of output, custom orders provide the bulk of the Decatur plant's work, although having product in stock has become increasingly important. "Customers want it now," says Helinski.

The plant operates its weld mill on two shifts instead of three. Helinski explains that this is because the company believes strongly in ongoing preventive maintenance as opposed to running machinery into the ground before replacing it. There are two full-time maintenance personnel on site for three shifts, allowing one full shift to be used for preventive maintenance. Downtime can be used to service the machinery as necessary, and Independence ships tubing on all three shifts at each location.

A walk through the 310,000-sq.-ft facility almost immediately reveals that Independence practices what it preaches: HSS is used everywhere, from the entrance canopy to the main structure and even the heavy tube-making machinery. Obviously, the facility didn't build itself; the HSS used to frame it was made in the Marseilles and Chicago plants. Of course, the mill is now capable of making its own HSS and can create product from 2½ in. square to 12 in. square, and 6⅝-in., 8⅝-in, 10¾-in, and 12¾-in. round (OD); wall thickness capabilities range from ⅛ in. to ⅝ in. In terms of length, the plant can produce sections up to 80 ft long.

Coiled Up

The interesting part is how these sections, whether 80 ft long or 20, come to be. HSS arrives in its final format in a much different manner from wide-flange steel. Where the latter is formed via the pouring of molten steel into dog-bone casts and rolled into its distinctive I

The slitter, creating two new widths of steel; sheared scrap (right) is recycled.

Coils in the staging area, following the slitting operation.

A steel coil, ready to be turned into HSS.

The leveler unravels the steel and flattens it.

shape, HSS is created from sheet steel that is hot-rolled into shape. Here's an over-simplified analogy: Think of taking a piece of paper and rolling it up, then taping the ends together. The process of making HSS is a high-tech, much more complex version of this, but you get the idea.

Here's how it works: Sheet steel arrives from the mill in coils, which look, to me, like huge rolls of metal toilet paper. Independence buys steel from multiple mills, and the Decatur facility receives most of its steel via barge—it's conveniently located along the Tennessee River—although it can also arrive by truck or rail.

Slit to be Rolled

Once it shows up at the plant, the sheet steel goes through several specialized machines before it ends up as tube. The first is the slitter, which, as its name suggests, slits the steel. Steel coil is fed into one end, where it unraveled. Next, the edges are slit off by round circular knives, which brings the coil to the proper width for the size of tube that is to be formed, and also creates smooth edges; the slitter is adjustable up to 74 in. wide. The steel is then recoiled onto another roll. The edge scrap is "balled" into separate collectors and eventually recycled. The operating station has a shield in front of it should the edge scrap, which is razor sharp, snap (although this has never happened here). The coil, now at the correct width, is staged until it is ready to be put through the mill.

The Never-Ending Ribbon

The mill stretches practically from one end of the building to the other. When in operation—i.e., when it's not shut down for breaks, shift changes, maintenance, or when the plant is closed—the mill essentially hosts a never-ending ribbon of steel.

A steel coil, after being sheared to the proper width in the slitter, is picked from storage via an overhead crane and fed onto a roll in the leveler. Like the slitter, the leveler—the first step of the mill—lives up to its name. As the coil is unraveled, the leveler draws it through rollers into a flattened state, working out any bumps or waviness. Next, the coil is butt-welded to the end of the last coil, although not all the way across—just enough so that it can be drawn along with the rest of the steel ribbon, which, again, never stops.

Buffer Zone

What makes this never-ending strand of steel possible is the looper or buffer, which is physically located at the near end of the mill, before the leveler (with the far end being final product). The looper works by creating a buffer or queue in the steel ribbon when a new coil is being added. This allows the mill to keep operating while a new coil is welded in place to again fill the looper (or queue) to capacity. There are different types of loopers in the tubing business. The one the Decatur plant uses is essentially a large drum that moves horizontally on a set of tracks in the opposite direction of the production process; a similar drum is at the far end of the leveler. So, when a new roll is welded into the line, it travels forward, loops overheard backward via the looper, then moves forward down through the rest of the mill proper. The process is repeated every time a new coil is added. A control screen shows how much time the looper

Flat sheet steel becoming rounder…

has and what length of steel is in the "storage queue" before the mill would need to be shut down. The transition is much like that made by club DJs segueing from one record to the next. A switch brings down the volume from the first record while gradually bringing it up on the second record. At the same time, the DJ can slow down or speed up either turntable so that the beat synchs up between the two songs, thus creating a seamless transition and the illusion of one continuous song. And like the HSS

…and rounder…

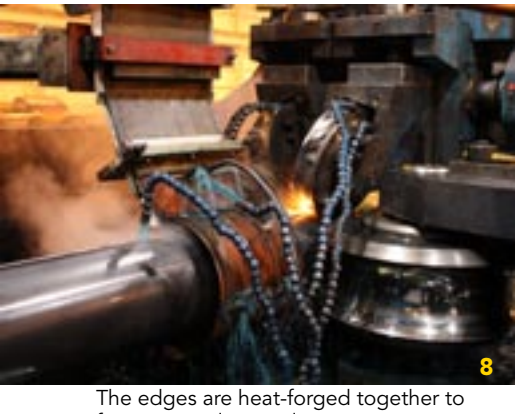
mill, he only has a certain amount of time to make it happen.

From Flat to Round

Once it's added into the ribbon, from the looper, the steel is pulled into the forming section. From this point forward, it is bathed in a synthetic coolant/lubricant along the line in order to dissipate heat and prevent "pickup" or steel adhesion to the tooling. The sheet is fed through a series of tooling that gradually forms the flat strip into a circle. (The forming section tooling is permanent and remains in place, but is adjusted for size made; the tooling in the remainder of the mill is changed for each tube diameter produced.) The edges are then welded together to complete the circle. Actually, "welded" is a misnomer in this case.

…and rounder.

They are actually forged together with heat and pressure. Ferrite is suspended inside the partially formed tube to direct the electrical current to the forge point. The outer-diameter weld slag (or "squeeze-out," as it is called) is scraped or "scarfed" from the tube to form a smooth seam (the other Independence facilities also perform inside diameter scarfing, which will be done at Decatur in the future). The strand of scarfed steel, much like the edge scrap cut via the slitter, is wound up into a separate roll, discarded, and eventually recycled.



The edges are heat-forged together to form a complete circle.

From Round to Square

From here, the newly formed round tube travels through a cooling trough before going through another series of tooling that will form it into a rectangular or square shape. (For tube that will end up as round, less tooling is required and part of this process is skipped.)

This "squaring section" uses a progression of three different sizes of tooling to press the round tube down on all sides into shape.

Newly formed tube enters the cooling trough before being cut or formed into a rectangular shape.

After each of the three points, you can see the tube gradually becoming closer and closer to being square. These dies are much smaller than the first set that forms the sheet into a round. Where the forming process uses both convex- and concave-shaped rolls that force the steel into shape, those in the squaring section press into the round at four distinct points, applying a precise level of pressure, to gradually "shape"

Steel is lubricated throughout the production line.

the round into a square or rectangle. As with the rollers that gradually bend the steel into round tube, these dies can be changed out to accommodate different sizes of square and rectangular product.

It should be noted that all tooling in all mill sections is hydraulically operated and adjusted. The mill also has the ability to repeat setups exactly, thanks to the computerized controls.

…is gradually pressed into…

Round tube…

...square tube...

...using interchangable dies...

Making the Cut

At this point, the forming is complete and the tube is now ready to be friction-saw cut. The friction cutoff, which uses a 65-in.-diameter blade, is a giant circular saw that moves with the tube by temporarily attaching itself to it—so as not to stop the continuous ribbon—and making the cut on the fly, so to speak. The effect is somewhat like watching two space vessels docking with one another, then detaching, while both are on the move—or watching a cartridge in an office printer moving back and forth.

Once the cut is made, the saw detaches and retracts to its starting point, ready for the next cut. Then the steel, still steaming, rolls onto a cooling rack/conveyor. Once it reaches the end, it is lifted by magnets, stacked into bundles to meet the customer specification, and banded together by workers. From here, the bundles are transported via another conveyor into the storage area, ready for shipping. As with incoming coils, truck, rail, and barge are used to deploy finished HSS product, with 90% of product being shipped via truck.

...on this machine.

The saw attaches to the tube and cuts individual sections.

Ladders Too

In the end, what was once flat is now round—or square or rectangular, depending on the order to be filled. Whatever its shape or size, each member comprises an efficient, aesthetic part of a sturdy framing system. And a versatile one too; even the portable ladders in the plant were made from tube! MSC

A recently cut section, on its way to packaging.

Ready for shipping!

For updated information on HSS shape availability, visit **www.aisc.org/steelavailability**. And for all issues related to HSS, visit **www.aisc.org/hss**.

Also, several domestic HSS mills are opening their doors on AISC's inaugural SteelDay, which takes place September 18. For more information on SteelDay and a map of planned events, visit **www.steelday.org**.